A SUBSURFACE STUDY OF THE ORISKANY SANDSTONE IN EASTERN OHIO AND SURROUNDING AREAS

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By

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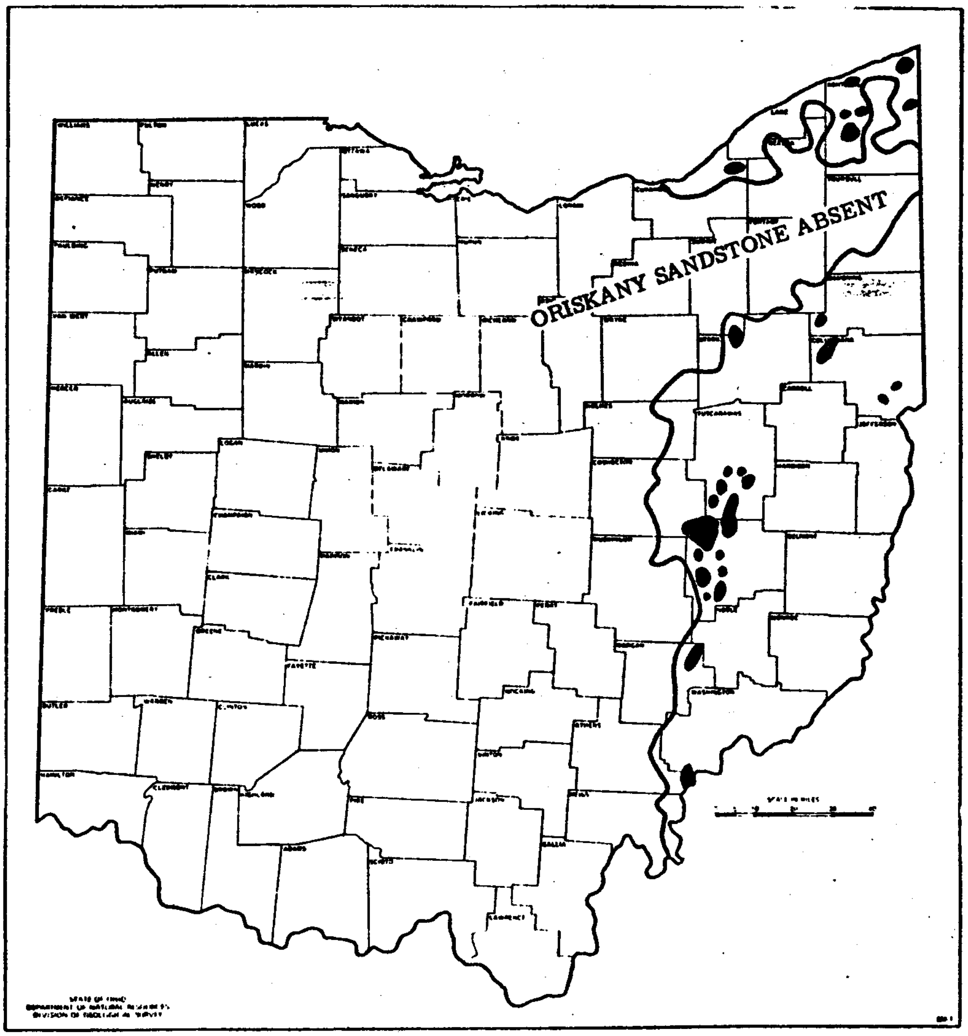
ORISKANY SANDSTONE ABSENT

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Introduction

Because the value of oil and gas has increased drastically over the last few years, it has become more economically feasible to locate small gas and oil pools which were once passed over for larger producing areas. Smaller "pay zones" are now becoming important once again in Ohio's oil and gas industry.

Natural gas is found in structural and stratigraphic traps in the Oriskany in Ohio, Pennsylvania and West Virginia. Although it is primarily a gas producing formation, some high grade oil has been produced.

The Oriskany is represented throughout the Appalachian area, extending eastward from an irregular North-South line reaching from Cuyahoga County, Ohio to the corner of Kentucky, Ohio and Virginia. It continues eastward, in the subsurface, until it outcrops in north western New York State, eastern West Virginia and Virginia. The sand is continuously distributed as a sheet sand in eastern Ohio except for small localized areas where it is absent due to erosion or non-deposition.

Because the Oriskany extends only into the eastern one-third of Ohio and is essentially undisturbed (except for the Cambridge Arch), development of producing fields in Ohio was thought not to be as great as in West Virginia and Pennsylvania where pronounced folding has occurred.

Oil from the Oriskany was first produced in Ohio from the Austinburg field, Ashtabula County in 1899. Since then, the largest field to be found (1922) is in Jackson Township, Guernsey County along the west flank of the Cambridge Arch (Lockett, 1937). Although thousands of wells have been drilled to the Oriskany in Ohio, neither the wedgeout to the west, nor the structural-stratigraphic traps in the down dip areas, have been thoroughly explored.

In West Virginia, production is usually bounded downdip by saltwater and updip by the sand grading laterally into shale. Many wells in western West Virginia produce a "wet" gas with small amounts of high grade oil. These fields are preserved in regions of almost horizontal bedding with very gentle regional dip to the east. Heating valves for western West Virginia gas is approximately 1,040 to 1,197 BTU. (Cardwell, 1974).

In Pennsylvania major production has come from the Ridgely sandstone, both structural and stratigraphic. The basal Onondaga and the overthrust belt are also probably future producing areas (Abel, 1981).

Depleted Oriskany gas fields are used for storage purposes in Ohio, West Virginia and Pennsylvania. The Oriskany sandstone is also noted as a high grade glass sand in outcrops from central Pennsylvania and northeastern West Virginia.

County	Township	No. Wells	Production (1000 MCF)
Ashtabula	Monroe	3	300
	Peirpont	2	39
Columbiana	Knox (1500/acre)	16	3,121
Cuyahoga	Highland Heights	5	2,239
	Mayfield	1	503
	Parma	5	606
	Royalton	11	2,342
Guernsey	Wheeling, Liberty, Knox		26,000
Mahoning	Smith	1	30
Medina	Hinkley	1	253
Portage	Randolph	1	50
Stark	Jackson	5	424
Summit	Bath	26	2,521
	Boston	8	432
	Franklin	1	72
	Richfield	23	1,886

Oriskany production, (Janssens 1976)

Fig. 1

Purpose of Study

The purpose of this paper is to describe and map the Oriskany Sandstone in eastern Ohio based on radioactivity well log data and core and cutting descriptions. A general subsurface study of eastern Ohio and adjacent areas (north western West Virginia and western Pennsylvania) was made in order to present a general interpretation with respect to hydrocarbon entrapment, exploration and production. A structure contour map, isopach map, cross-sections and stratigraphic column were constructed from gamma-ray and neutron well logs to interpret various structural, stratigraphic and paleogeomorphic hydrocarbon traps. All were compared to previous Oriskany studies in Ohio, West Virginia, Pennsylvania and New York.

Methods of Study

Gamma-ray logs of wells in Eastern Ohio, on file at the Ohio Department of Natural Resources, Geologic Survey, were used to arrive at most of the interpretations and conclusions of this paper. Well cuttings were not examined by the author, but cutting and core descriptions on file at the Ohio Department of Natural Resources were analyzed as well as petrographic descriptions from Stow 1937, Lafferty 1937 and Hall 1951. Descriptions by these previous authors are in general agreement, and together with the study of gamma-ray logs, provided a sufficient picture of the rock types discussed in this paper. (Core and cutting descriptions are at the end of the paper, Appendix A.)

Radiation Logs and Their Interpretation

There are two types of Radiation logs, gamma-ray and Neutron.

The gamma-ray log is a measurement of the natural radioactivity of rock formations in the subsurface. The principle sources of naturally contained radiation in sedimentary rocks are Potassium 39, Uranium Series, and Thorium Series.

In general, limestone contains little radioactivity, sandstone contains moderate amounts of radiation due to shale content and interstitial clays, and shale contains high radioactivity due to K+ inherent to clays. Therefore gamma-ray logs are very useful in determining lithologic characteristics of the rocks in the subsurface.

A scintillation counter in the gamma-ray tool is lowered into the borehole and measures the radiation emitted by the radioactive elements in the rock. The detector carries this information up to the recording instruments where it is displayed on a strip chart (or well log). Deflections toward the right of the log indicate high radioactivity, and deflections toward the left indicate low radioactivity.

Fine grained sediments such as shales are more radioactive than coarser-grained sediments and carbonates. Siliceous and calcareous sediments that lack clay are usually low in radioactivity. (fig. 2)

The nuclei of all elements except hydrogen, contain neutrons. A Neutron has about the same mass as a hydrogen atom, but is not charged.

Neutrons are emitted from fissionable material with extremely high velocities, and are slowed down only by collision with other atoms. The most effective atoms in slowing down neutrons are those with the same mass. Therefore the neutron is slowed down most efficiently by collision with hydrogen atoms. Because water, oil and gas contain more hydrogen than rocks, emitted neutrons are able to be used to determine hydrogen content of a formation.

The neutron log indicates the porosity of the rock formations by bombarding the rock with neutrons. When neutrons enter formations that are dry, they will not immediately be slowed and will penetrate the rock until they collide and are captured by some element. When neutrons enter formations that contain fluid, the emitted neutrons are quickly slowed by collisions with hydrogen nuclei. Thus, shales deflect readings on a strip chart to the left because of their water content.

The neutron curve on the strip chart responds to changes in hydrogen content, so a qualitative and quantitative porosity may be determined. This is due to the fact that all formation voids are filled with either oil, water or gas, and only rarely air.

Porosity may be qualitatively determined by dividing the strip chart and interpreting the largest as opposed to smallest deflections. (fig. 2)

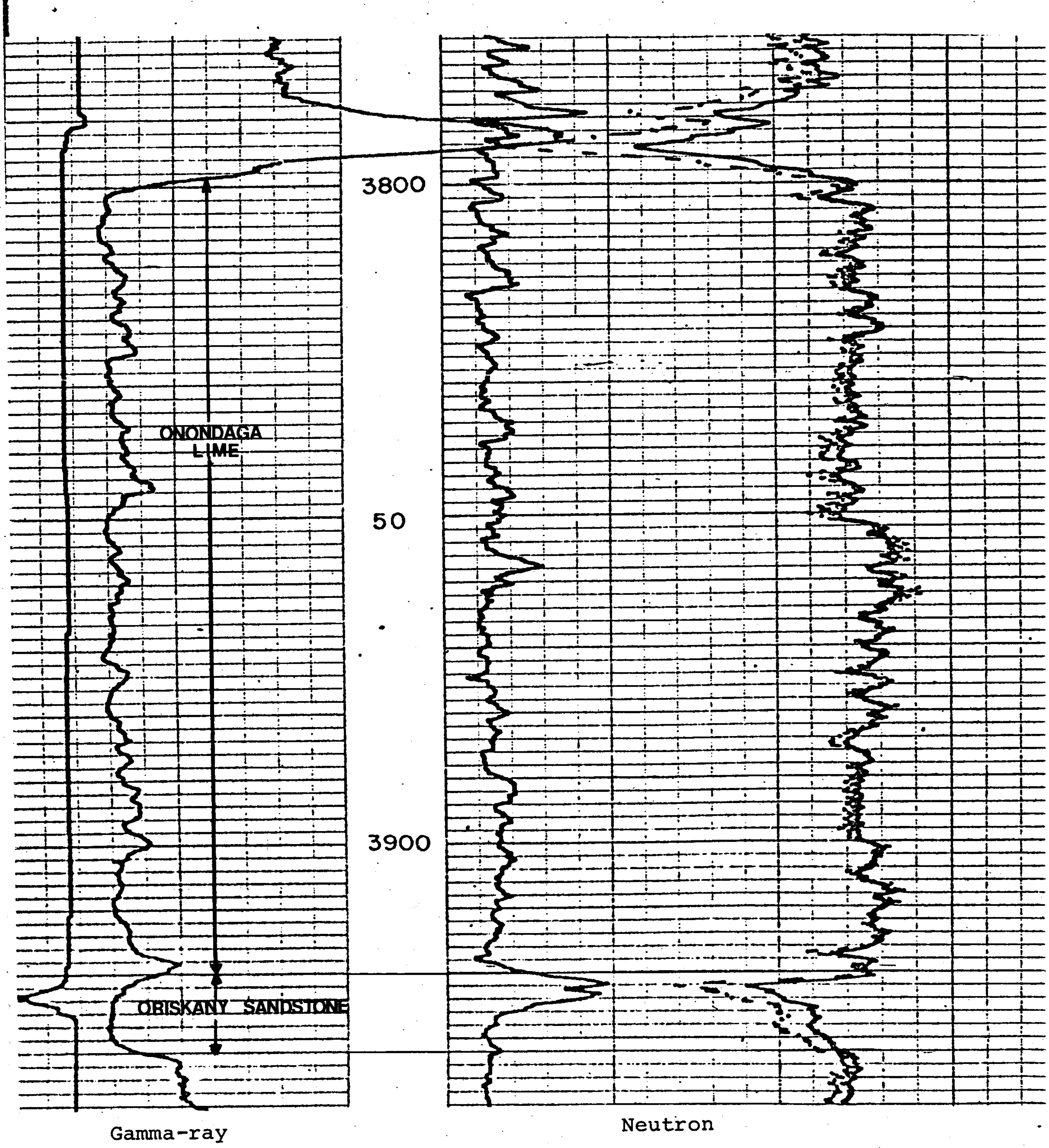


Fig. 2 Characteristic signature of the Oriskany sandstone. Above it is the "Onondaga Lime", and at 3800' is the bottom of the Olentangy shale.

Quantitative porosity may be determined by realizing that the lowest neutron deflection will be opposite shales and the highest next to dolomite or other non-porous rock. (Gatlin, 1960)

Gamma-ray and neutron analysis were both used in determining the characteristic signature of the Oriskany sandstone. Because the Oriskany is a relatively thin horizon in Ohio, and a pure sand with a calcareous cement, it is sometimes nearly indistinguishable between its calcareous upper and lower contacts. The neutron density curve is often used to determine the Oriskanys' relative position below the Onondaga, as the Oriskany is sometimes referred to as the "first water". Many depths and thicknesses were made on an interpretive and calculated basis. Oriskany characteristic signature, fig. 2, shows a distinguishable Oriskany sandstone below the Onondaga lime, although the Oriskany often does not look like this.

Geologic History

The rocks of the first three stages of the Devonian (Helderberg, Deerpark, Onesquathaw) are indicative of deposition in a broad, sporadically subsiding, sea shelf. The Devonian strata, in general, suggests that deposition was almost continuous. The thickness of the sediments is greatest along the trough from New York to Virginia. The sediments thin and pinch out southward along the axis of the trough and westward on to the craton. (Oliver, 1968)

At the beginning of the Devonian, the land mass along the eastern edge of the North American Continent was slightly higher than sea level. At this time, little clastic sediment was supplied to the Appalachian trough. The Helderberg limestones and shales accumulated in a narrow well protected sea.

Chemical decomposition of the low lying land to the east was an important factor in supplying great masses of fine to coarse grained quartz clastics to the Appalachian lowlands. (Fettke, 1938)

Much of the Deerpark Stage deposits were carbonates in the north central part of the basin, but a great deal of quartz clastics were derived from a source area east or southeast of central Maryland. (Fig. 3) The absence of lithic fragments does in fact suggest a pre-existing well weathered sedimentary source rock. (Oliver, 1968)

Slight uplift during late Oriskany time caused the sand from the east to be transported west to the shallow Oriskany sea. Sand was spread westward. The advancing sea subjected the sands to the physical marine environment. (Fettke, 1938)

Early Devonian fossils found in the Oriskany do indicate age and general marine character. The predominant pure quartz sand, along with

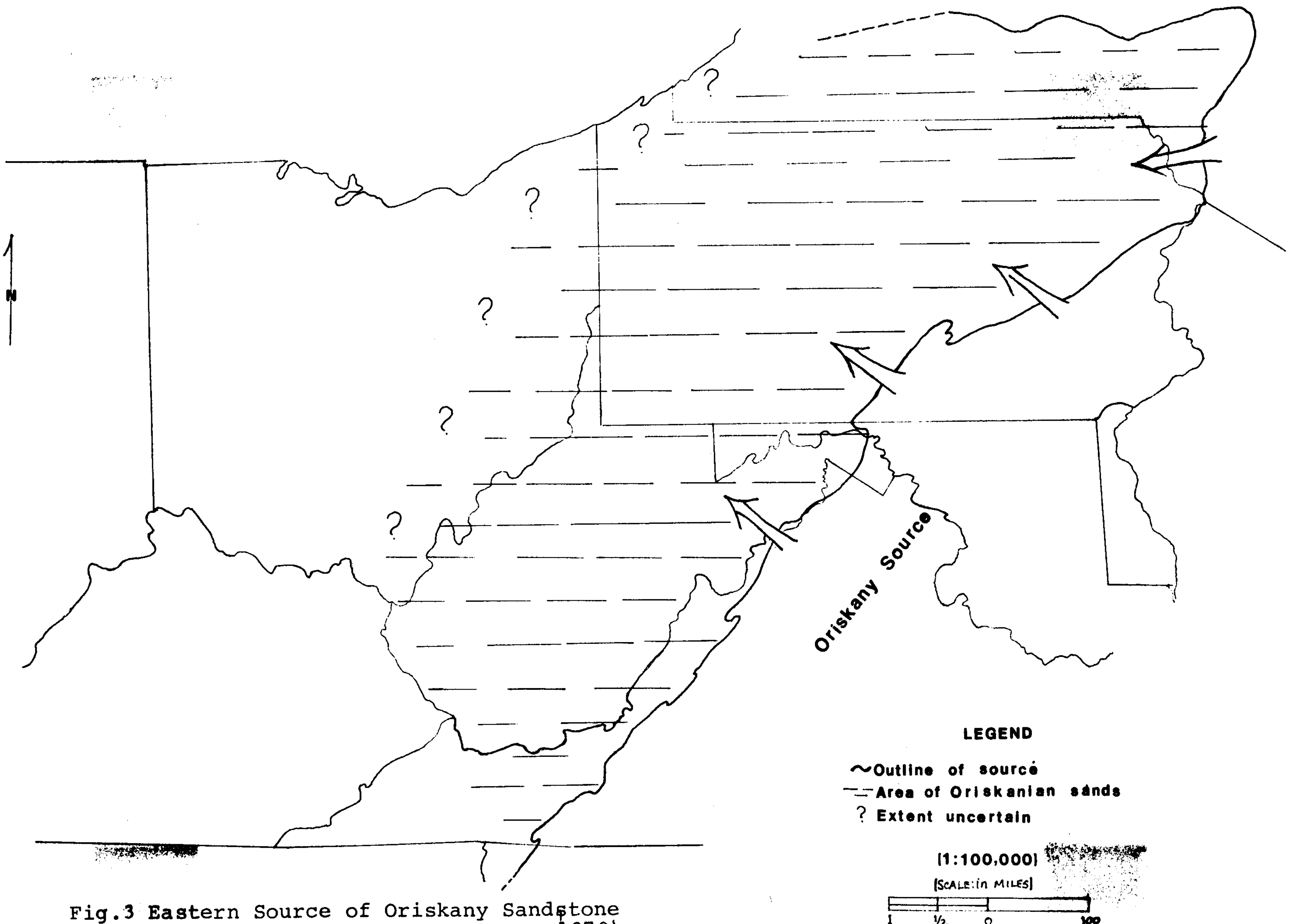


Fig.3 Eastern Source of Oriskany Sandstone
(From C.H.Summerson,D.H.Swann,1970)

marine fauna is indicative of a near shore, shallow water environment of deposition at the eastern edge of the geosyncline. Transgression of the Oriskany sea westward is indicative by the deposits of sandstone overlapping older formations. Transgressions and unconformities are also evident with older limestone formations found within the basal beds of the sandstone. (Stow, 1938)

Extensive deposition and erosion occuring after the pre-middle Devonian uplift continued through most of Deerpark time, creating an disconformity between the Oriskany and the Bois Blanc Formation or Onondaga limestone.

Continual transgression of the sea to the west and downwarping of the craton covered the Oriskany sandstone with calcareous sediments and facies changes to shales westward, creating a stratigraphic "lid" for later hydrocarbon entrapment.

Stratigraphy

The Oriskany Sandstone is of Early Devonian, Deerpark Stage, Ulsterian Series in age. (Figs. 4). It was first named by Hall and Vaneuxem in 1939 in describing the sandstone formation cropping out at Oriskany Falls, Oneida County, New York where it is a nearly pure quartz white friable sandstone. (Stow 1938, Fettke 1937)

The Cambridge Ohio field well cuttings have been correlated paleontologically with outcrops in central Pennsylvania and eastern West Virginia. (Hall, 1951)

In general, the Deerpark Stage Formations are mostly composed of clastic quartz. The Deerpark sandstone contains a distinctive brachiopodal fauna with thick shells. (Oliver, 1968)

The Oriskany is a white to brownish gray predominantly medium to coarse grained sandstone, fining westward, the grains vary from angular to sub-rounded with the larger tending to be almost well-rounded and often frosted. Normally, the coarser grains are found at the top of the formation. Many gas fields suggest a shallow water deposition with local cross-bedding. The cement is mostly calcareous, less often being dolomitic or siliceous. Accessary minerals frequently found are chert, glauconite, iron oxide and zinc sulphide. (Hall 1951, Lafferty 1937, Stow 1937) Core and cutting descriptions may be found in the appendices at the end of the text.

The Oriskany does not outcrop anywhere in Ohio, and subcrops only in the eastern one-third of the state. Ranging in thickness from two feet to one hundred plus feet, with the average being approximately eighteen feet, it has a maximum known thickness of one hundred five feet in southeastern Monroe County. (Hall 1951, Janssens 1977)

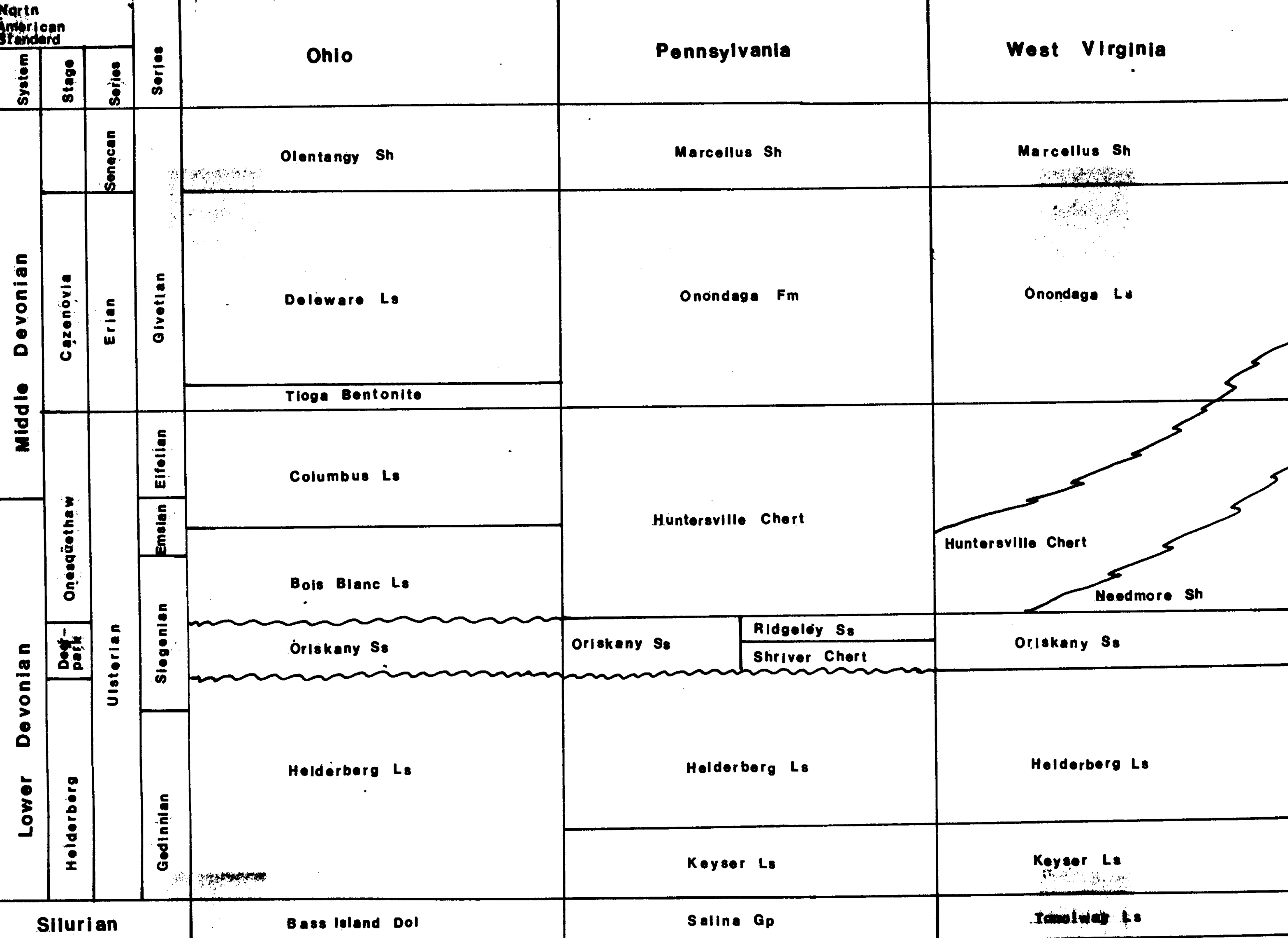


Fig. 4 Generalized Stratigraphic Column of Ohio, Pennsylvania and West Virginia

In Ohio and surrounding areas, the Oriskany has been called the following: Cambridge gas sand, lime sand, Corniferous lime sand, Monroe lime sand, Jefferson gas rock, and Austinburg (Hall, 1951). The Corniferous name is applied to the section from the top of the Onesquathaw Stage to the Lockport Formation of Middle Silvrian age.

The Oriskany in Ohio is considered to lie unconformably above the Helderberg Limestone and unconformably below the Columbus and Delaware Limestone (the two together are referred to as the "Onondaga Lime"). The Bois Blanc Limestone or equivalent may be included at the base of the "Onondaga Lime". (Janssens 1977, Hall 1951)

The Onondaga Limestone is a cherty fossiliferous limestone with a maximum known thickness of 400 feet in Northeastern Ohio. The Helderberg Limestone is an argillaceous and cherty fossiliferous limestone with a maximum thickness of 140 feet. (Janssens, 1977)

The basal Onondaga and Bois Blanc Formations are very sandy in places. Being at the same stratigraphic position as the Oriskany, they are sometimes confused by the driller as being the Oriskany Sandstone. (Janssens 1977)

The interval between the top of the Onondaga Lime (top of the Deleware limestone) and the top of the Oriskany varies over the state. The minimum being forty-two feet and the maximum 400 feet with the average at about 160 feet. The wide variance in depths is due to the disconformable contacts above and below the Oriskany. (Hall, 1951) A stratigraphic column figs. 4,5 and correlation chart has been included to illustrate the system.

In Pennsylvania the Oriskany Sandstone is made up of two distinct formations related closely by a similarity in faunal content. The upper sandstone beds are called the Ridgely Formation. These in turn are divided

Time-Stratigraphic Units			ROCK UNITS		
System	Series	Stage	Group	Formation	Drillers or Informal Names
Middle Devonian	Erian	Cazenovia		Delaware Ls.	Big Lime; Corniferous; Onondaga Lime
	Ulsterian	Onesquathaw	Detroit River	Columbus Ls.	Big Lime; Corniferous; Onondaga Lime
Lower Devonian	Ulsterian	Onesquathaw		Bois Blanc Fm.	Big Lime
	Ulsterian	Deer-park		Oriskany Ss.	Big Lime; 1st Water
	Ulsterian	Helderberg		Helderberg	Big Lime
Silurian				Bass Island Dol.	Big Lime

Fig. 5 Stratigraphic Nomenclature of Ulsterian Series and Adjacent Formations

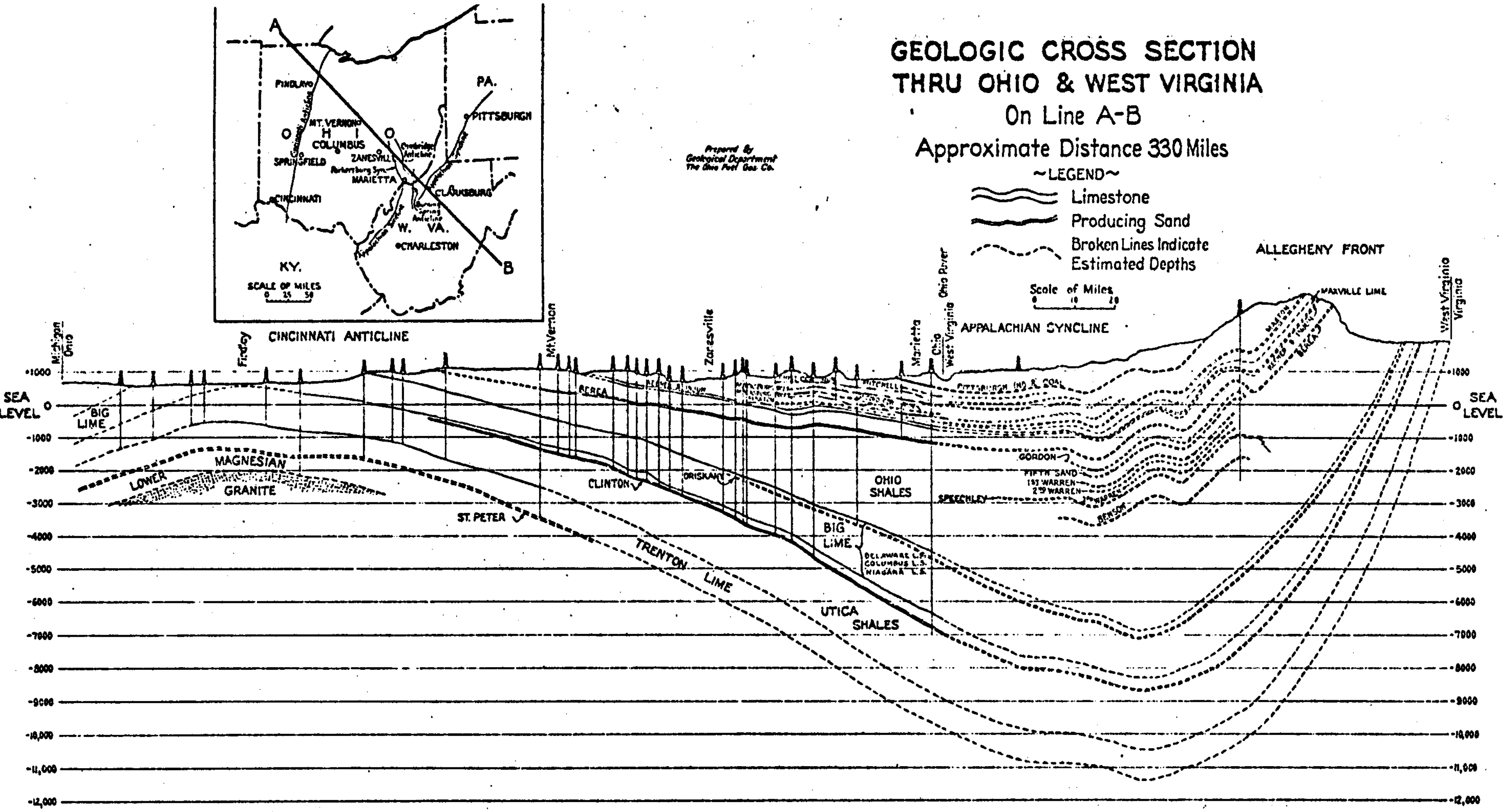
into two sandstones; the Ridgely, a clean sandstone that thickens to the southeast, and the Oriskany sandstone (interpretted to be basal Onondaga) Northwest of the Ridgely, showing no regular patterns and commonly containing glauconite and shale. The lower formation, called the Shriver formation, contains siliceous limestones, shales and cherts. The Oriskany rests disconformably on the Helderberg Group and unconformably below the Onondaga Group. (Abel 1981, Fettke 1951)

In northwestern Pennsylvania there is a large region where the sand is not present. This area may coincide with an old arch which is pre-Onondaga or Pre-Oriskany in age. (Finn, 1942)

Oriskany (Ridgely) production is both structural and structural stratigraphic, especially where the Ridgely pinches out.

In West Virginia the lower Oriskany or Ridgely sandstone rests on the Shriver chert, a member of the Helderberg Group. (Lafferty, 1937) The Helderberg Group, characterized by a cherty limestone, sometimes has a sandy upper phase which is often confused with the Oriskany in the western part of the state. Overlying the Oriskany or Ridgely sandstone are three intertonguing formations, the Huntersville Chert, Onondaga Limestone and the Needmore Shale. The Onondaga Limestone is predominant in western West Virginia. (Cardwell 1974, Lafferty 1937) The West Virginia Geological Survey recognizes no unconformities between the upper and lower boundaries of the Oriskany.

Whether the sand west of the Cambridge field in Guernsey County is Oriskany or basal Onondaga, producing wells have been drilled to this horizon, just as in northwestern Pennsylvania, where the same stratigraphic question arises.



GEOLOGIC CROSS SECTION
THRU OHIO & WEST VIRGINIA
On Line A-B
Approximate Distance 330 Miles
~LEGEND~
Limestone
Producing Sand
Broken Lines Indicate
Estimated Depths
Scale of Miles
CINCINNATI ANTICLINE
APPALACHIAN SYNCLINE
ALLEGHENY FRONT
Michigan
Ohio
Findlay
Mt.Vernon
Zanesville
Marietta
Ohio
West Virginia
Ohio River
West Virginia
Virginia
SEA LEVEL
BIG LIME
LOWER
MAGNESIAN
GRANITE
ST. PETER
TRENTON LIME
UTICA SHALES
CLINTON
ORISKANY
BERCA
BIG LIME
OHIO SHALES
DELAWARE L.S.
COLUMBUS L.S.
NIAGARA L.S.
PITTSBURGH (NO. 8) COAL
GORDON
FIFTH SAND
1ST WARREN
2ND WARREN
SPEECHLEY
BENSON
MAXVILLE LIME
KY.
PA.
O H I O
W. VA.
PINDLAYO
MT. VERNON
COLUMBUS
ZANESVILLE
SPRINGFIELD
MARIETTA
CINCINNATI
CLARKSBURG
PITTSBURGH
CHARLESTON
SCALE OF MILES
A
B

Fig. 6

Small areas of Oriskany Sandstone, isolated beyond the western edge of the main sand sheet, and Oriskany sand (or its stratigraphic equivalent) found reworked in basal overlying formations past the present questionable limits of the Oriskany, indicates that Deerparkian strata were deposited over a more extensive area than they are presently found. This sand is thought not to have covered the Cincinnatti Arch (Oliver, 1968). Regional evidence suggest both pre and post Oriskany erosion on the margins of the basin. (Oliver, 1968)

Entrapment of Hydrocarbons

Structural-

Most often, the accumulation of hydrocarbons is along crests or slopes of anticlines. The hydrocarbons are carried updip due to saturation by salt water. Hydrocarbons will most likely be found where sand is fairly porous, saturated with water and formed into an anticlinal fold.

Many Oriskany producers of eastern Ohio, in the early 1940's, thought Oriskany sand production, with some exceptions would be found along the axis of main anticlines and only in the closed structures. (Myers, 1937) Although hydrocarbon accumulation is often found in this setting, Oriskany fields have been found to be of both structural and structural-stratigraphic types.

In Pennsylvania natural gas is present in both strucutral and structural-stratigraphic traps, along or near axis of anticlines, and traps associated with subsurface overthrusting. (Abel, 1981) In West Virginia anticlinal features are traps, but most production is controlled by permeability and porosity. (Cardwell, 1977)

The direction of dip of the rocks in eastern Ohio, is south eastward. This region forms the western sides of a shallow broad basin. (fig. 6)

The basins slopes are not uniform and have many shallow, rolling anticlines and synclines.

In eastern Ohio there are no pronounced folds except for the Cambridge Arch. (Myers, 1937)

Situated along the main axis of the Cambridge Arch is the Cambridge Field. Although the Cambridge Field does not exhibit closed structures, significant amounts of folding is present. Entrapment of hydrocarbons is most likely the result of the closeness to the western limits of the Oriskany sand. (Myers, 1937) Gas and oil have been found trapped above the water near the approximate limits of the Oriskany sand body. (Lockett, 1937) Plate 3 shows the approximate limits of the Oriskany sand.

Under the Cambridge Arch the Oriskany structure is a gently eastward dipping terrace at an average slope of 75 feet per mile. Commercial production exists west of the Parkersbürg-Lorain Syncline in the Oriskany sand. The sand under the Cambridge Arch, south of Guernsey County is thought to be wet. Even though the Oriskany sand does exist here, there probably are no structural forms that create highs and bring the Oriskany out of the water. (Lockett, 1937)

Janssens (1974) discusses the northeastern fields and the structural highs that locally uplifted the Oriskany and formed lows in which salt water creates downdip barriers. The structural highs are believed to have formed due to thickening of underlying Silurian salt beds in late or post-Paleozoic time.

In Columbiana County most drilling has been on anticlinal structures. This area is more like western Pennsylvania than eastern Ohio. (Myers, 1937)

Plate I is a Regional structure map of the top of the Oriskany Sandstone, constructed from gamma-ray and neutron well log data. It is in general agreement with structural maps of West Virginia and Pennsylvania. In eastern Ohio the strike is generally northeast-southwest and the dip is approximately 35 to 98 feet per mile toward the southeast. The 250 foot contour interval used in construction of this regional structure map is much too great to reveal any of the details of the Oriskany sub crop surface. Refinement at smaller contour intervals with greater drill data density will be necessary to dilineate specific structures with accuracy. Conditions of oil accumulation in structures are controlled by so many intangible factors that no one can, with certainty, predict the location of oil pools before drilling.

Stratigraphic

The majority of the pools in central and southeastern Ohio are formed by the updip wedgout at the western limits of the sand body. (Janssens, 1977) Most of the Oriskany production in Ohio, and West Virginia is of this type. Entrapment occurs at the western shoreline limit of the Oriskany "Sea" with gas held between impermeable rocks and downdip salt water. (Myers, 1937) Similarily, in Pennsylvania, trapping occurs in updip wedgout settings where the Oriskany is absent. Small traps may occur where pools are formed at updip permeability and porosity pinchouts and small sand wedgouts. (Janssens, 1977)

The development of important fields such as the Cambridge field, and Elk-Poca field in West Virginia, most probably may occur in other similar sedimentary and structural conditions where the western edge of the sand body lies along a terrace in which the sand dips steeply to the east. (Lockett, 1937)

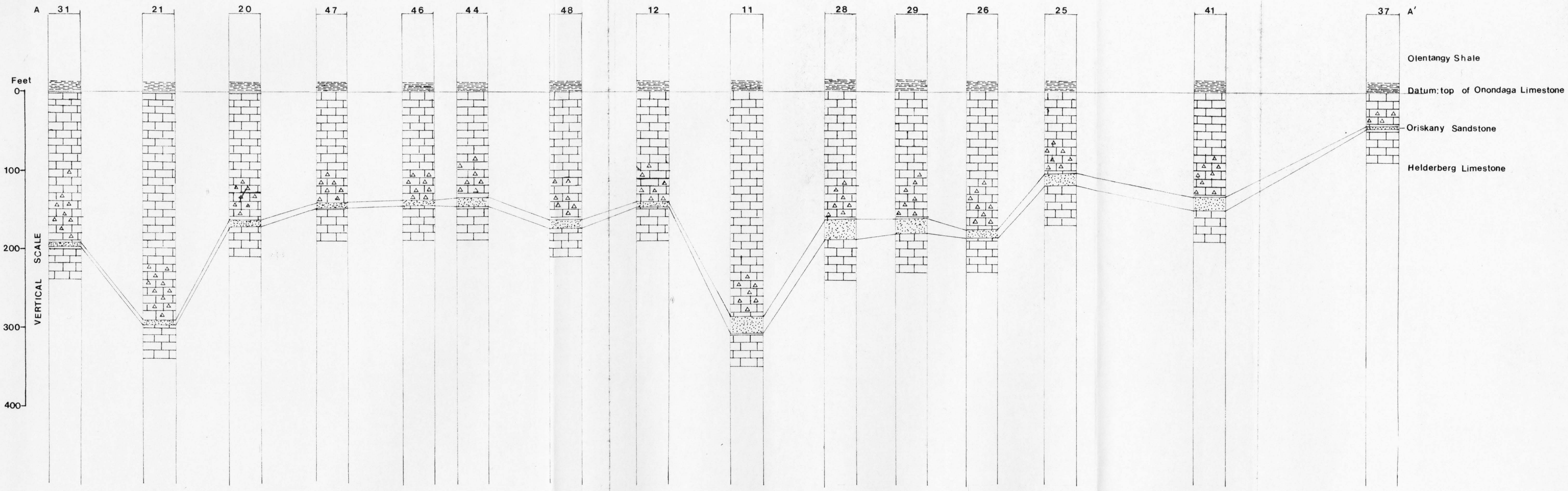
Plate II is a regional isopach map of the Oriskany sandstone, constructed from gamma-ray and neutron well log data. It is in general agreement with West Virginia and Pennsylvania isopach maps. This map exhibits general thicknesses and approximate limits of the sand pinchout to the West. The western extent of the sand body is by no means exact. This is due to lack of well data and because of the sporadic erosion and reworking of the sand by a post-Oriskany Sea and/or the failure of deposition due to decreasing depth of water toward the shoreline or shallow water along the east side of the Cincinnati Arch. For future hydrocarbon exploration, detailed isopach mapping of the Oriskany should be made to determine the location and thickness of the western wedge edge sands. Important fields may be found where a thick porous sandstone is in close proximity to the updip wedgout of the western limits.

Paleogeomorphic

Paleogeomorphologic features developed on an erosion surface may be reconstructed by preparing an isopach map of the stratigraphic interval between the unconformity and the next overlying marine horizon.

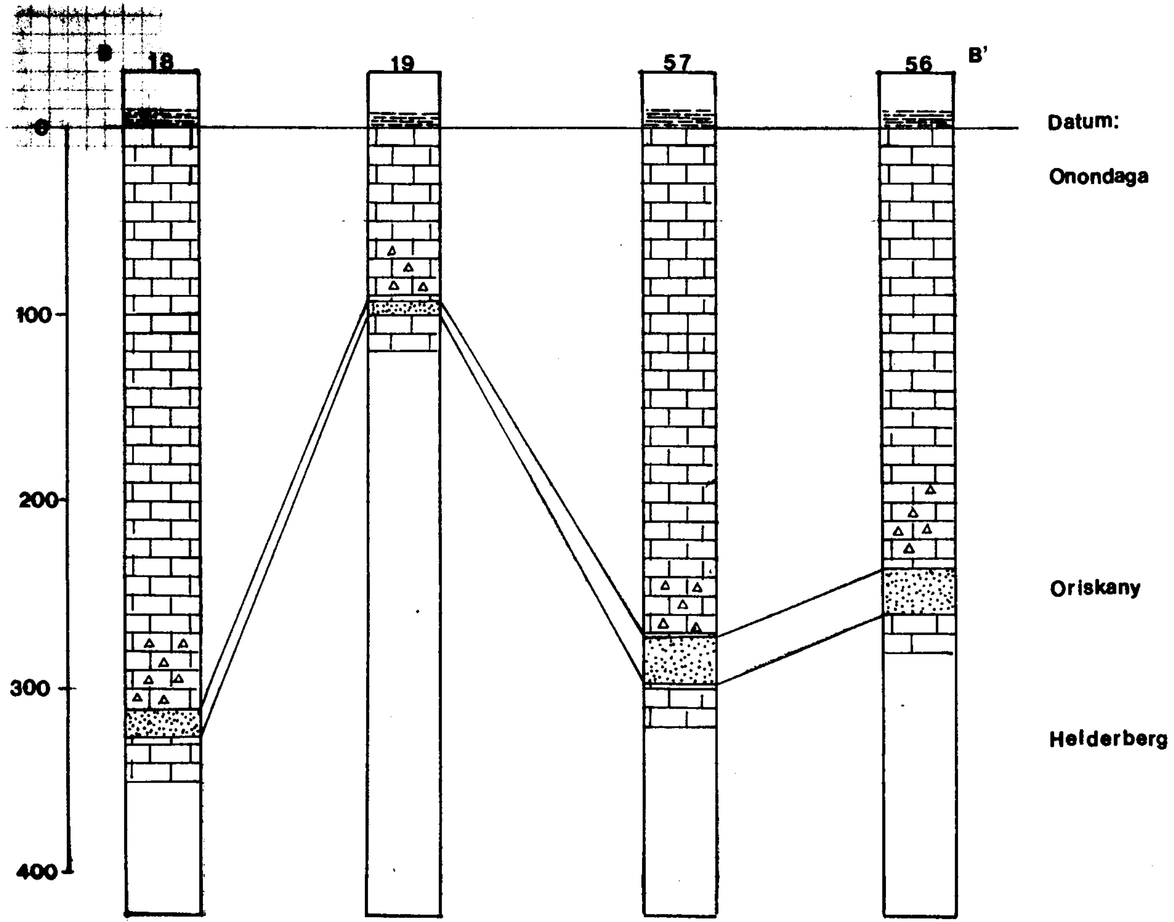
Suggested erosional relief on the top of the Helderberg in pre-Oriskany time may be indicative of traps created on the highs and in the lows of the Oriskany Sandstone. Pre-Oriskany topography may have influenced sand distribution and faces variations within the Oriskany horizon. Uneven paleotopography is evident in the five cross-sections (Figs. 7,8,9,10,11). Local thinning and thickening of the Oriskany, together with varied thicknesses of the overlying Onondaga Lime may be indicative of a hiatus between the two formations. These small erosional surfaces may be evidence of paleogeomorphic traps.

Paleogeomorphic traps have been major hydrocarbon producers in Ohio (such as the Copper Ridge Dolomite as described by Dolly and Busch, 1972). Paleogeomorphic traps in the Oriskany are probably small and occur only where topography is appropriate.



APPROXIMATE HORIZONTAL SCALE: 1": 16 MILES

Fig. Cross Section A-A', Showing Onondaga- Oriskany Interval



Approximate Horizontal Scale: 1" = 16 Miles

Fig. 8 Cross Section B-B', Showing Onondaga-Oriskany Interval

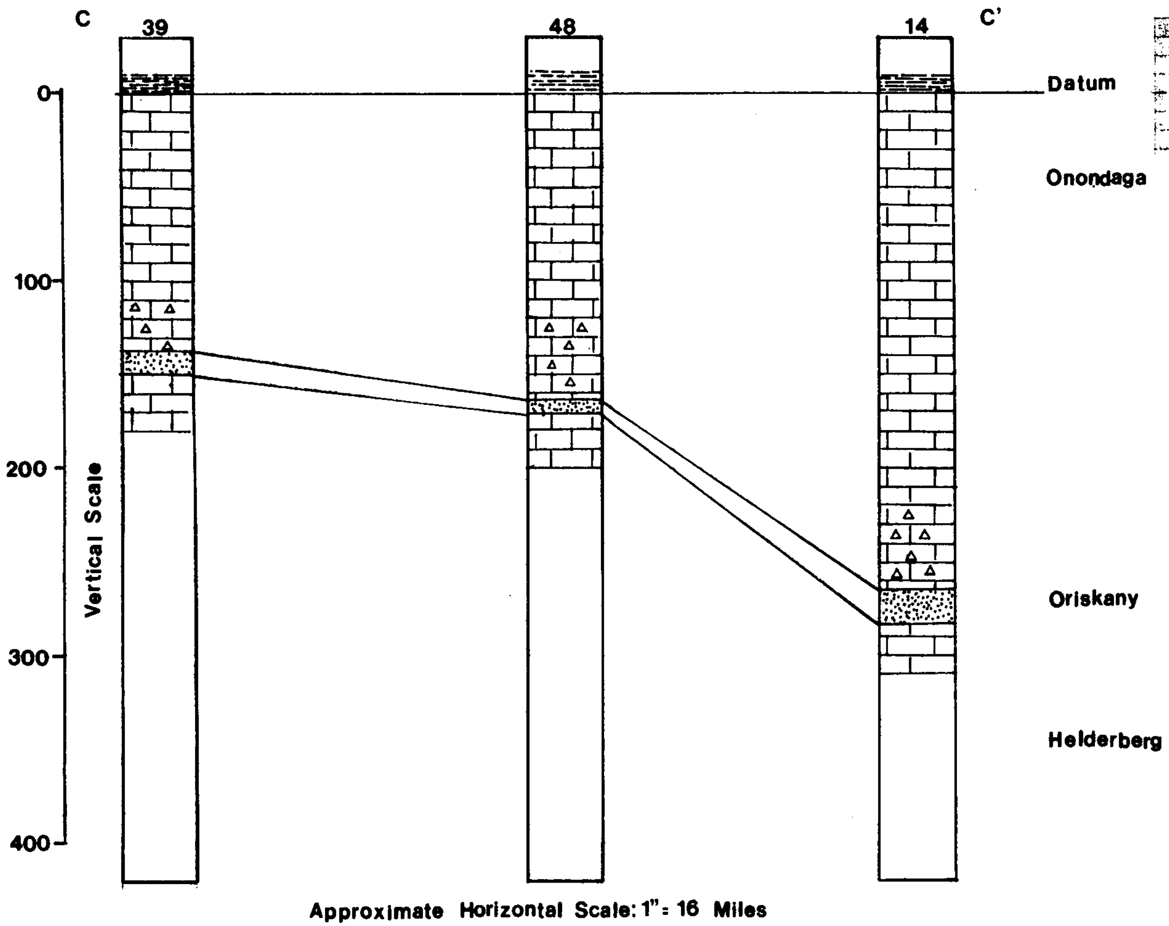


Fig. 9 Cross Section C-C', Showing Onondaga-Oriskany Interval

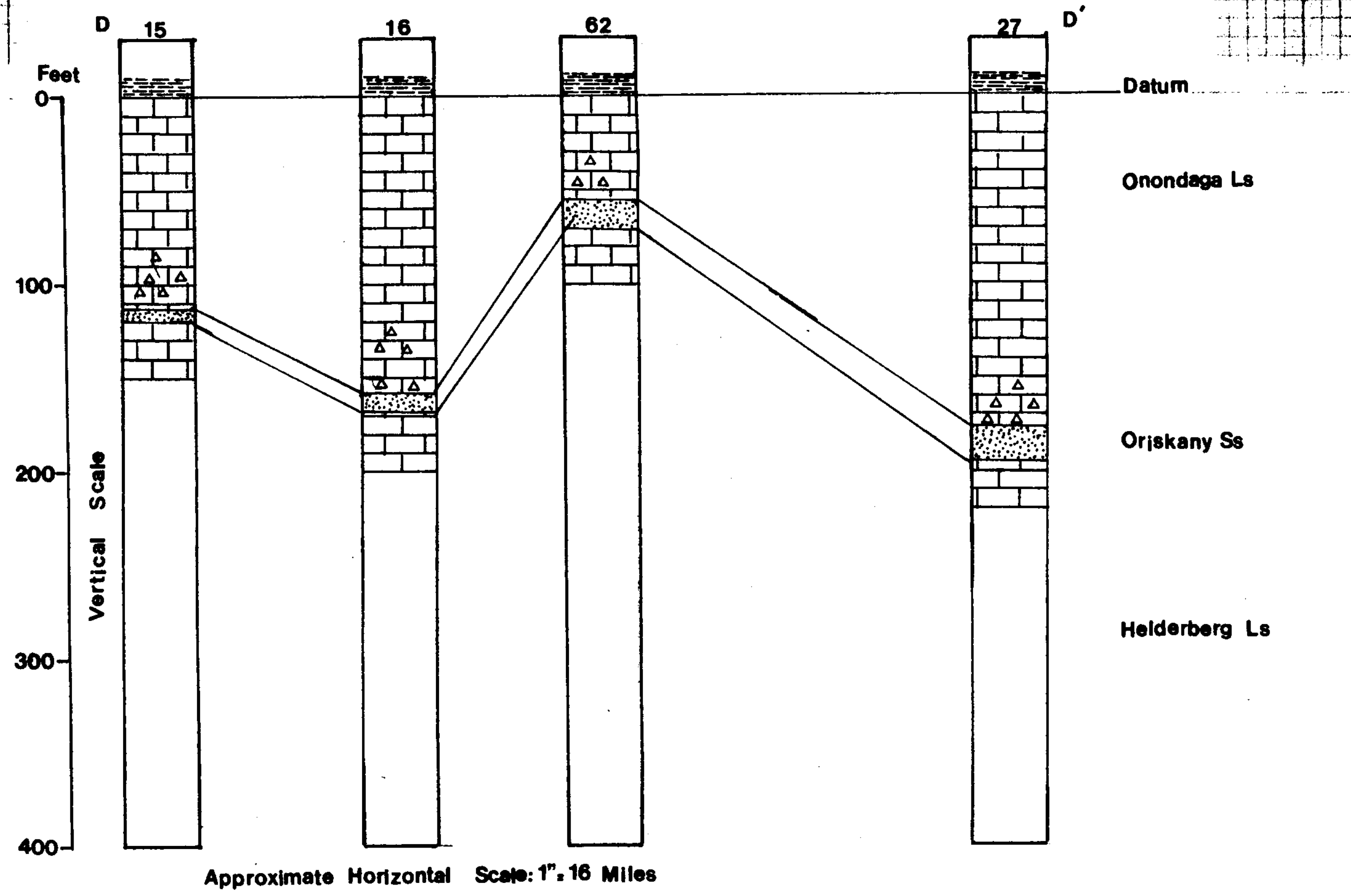


Fig. 10 Cross Section D - D', Showing Onondaga-Oriskany Interval

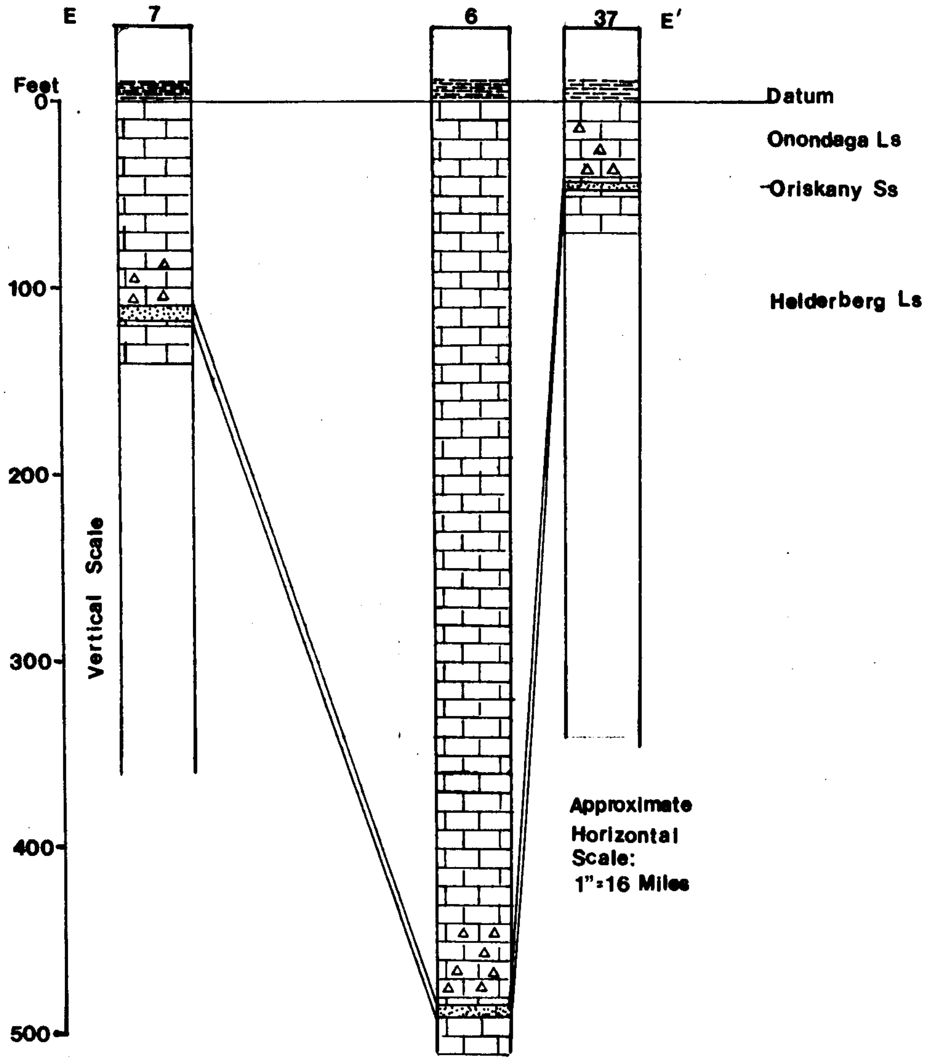


Fig. 11 Cross Section E-E', Showing Onondaga-Oriskany Interval

Cross sections we constructed from gamma-ray neutron well log data to determine stratigraphic relations of Onondaga and Oriskany Formations, Figure 7,8,9,10, (cross sections A-A', B-B', C-C', D-D' and E-E' respectively) are representative of five regional cross-sections. The top of the Onondaga was used as the reference datum for these five profiles, to remove the effects of post depositional regional tilt. However, the use of this datum accentuates pre-unconformity structure of the Oriskany. Cross section A-A' (fig. 7) is an approximate north-south trending profile. Figures 8,9, 10, 11, are approximately east-west, but were constructed as prependicular to strike as possible.

Porosity and Permeability

The accumulation of Hydrocarbons, entrapped within geologic structures, depends on the condition of saturation of hydrocarbon bearing rocks.

Because of the difference in specific gravities, oil and gas in a porous rock that is completely saturated with water will be forced up to the top of the rock.

"The conditions of saturation of water is not the same in different sands. The older or lower beds in the Appalachian field contain a smaller area of completely saturated rock than younger beds." (Manger, 1963) In porous, dry rocks, the main areas of accumulation of hydrocarbons will be at the bottom of synclines. Most generally, rocks are found in a semi-saturated state, and the accumulation of oil may occur anywhere in a geologic structure.

"The porosity of a sandstone generally decreases and bulk density increases with depth of burial, age, degree of tectonic activity and departure from homogenous mixture." (Manger, 1963)

In West Virginia, Pennsylvania, and Ohio the Oriskany has a porosity ranging from three percent to fourteen percent, with the average being ten percent. (Manger, 1963) Permeability averages less than 500 millidarcy's (Fenton, 1949) This permeability has been augmented in numerous producing fields by small open fractures that appear to be joint planes. These joint planes have induced greater flow capacities than the average producing sand in the Appalachian area. (Finn, 1942)

In Ohio, the density porosities are about ten percent to twelve percent paralleling the wedgout. Downdip, the porosity decreases probably due to burial and/or other effects mentioned above. (Janssens, 1977 Finn, 1942) Where sands are thin and near the western limits, porosity can be expected to be reduced. Hydrofracing or other techniques used in increasing permeability and porosity may be needed to increase production in low porosity and permeability areas.

In some areas, such as Tioga, Pennsylvania, porosity and structure are interrelated. The sand tends to be much more porous on the high parts and of anticlines containing gas with areas farther down the flanks being relatively non-porous and void of gas and water. This may suggest slight uplift at the close of the Oriskany time making it possible for the sand to have been reworked, bringing better sorting at the high points of the structure. (Finn, 1942)

It can not be expected to find oil and gas even in the location structurally most favorable. The accumulation in pools is controlled by factors such as trend, extent, texture of pay zone and degree of saturation by salt water. Although most pools follow the strike of the rock (Plate 1) and extend parallel to structure contours, the explorationist must be able to determine in which direction the next location should be made to find oil, after a well showing hydrocarbons and salt water has been drilled.

Origin and Migration of Hydrocarbons

Wherever resevoir rock contains organic materials such as shales and limestones, there is the possibility of hydrocarbons forming in situ. Such organic strata sandwich the Oriskany sandstone. The Oriskany is the most productive of its nearest underlying and overlying horizons due to its relatively high porosity and permeability. Because oil and gas have been known to migrate great distances, it is possible that Oriskany hydrocarbon source rock may be in a down dip or basinward direction, and the Oriskany Sandstone may have provided a continuous pathway for such long distance migration. It is plausible that hydrocarbons formed within the overlying Middle Devonian Shales to have been differentially compacted and forced westward updip and/or laterally into adjacent resevoir rock. Because resevoir type strata surrounding the Oriskany Sandstone contain relative amounts of hydrocarbons, it does not seem possible for the author to conjecture on the exact source rock for the producing Oriskany horizon.

Conclusion

Conclusions of this study rely almost solely on radiation well log interpretation. Results are in general agreement with previous studies. New and differing results were arrived at due to increased well log data in areas of recent exploration.

The results of this study may be concluded as follows:

The Oriskany Sandstone is a competent resevoir for entrapment of hydrocarbons in Ohio.

The western updip pinchout should be explored and mapped for future producing fields.

Exploration to the Oriskany horizon is likely to produce from paleogeomorphic and small structural traps as more controlled radiation well log data will increase the accuracy in prediction for such entrapment.

Perhaps, in the future, exploration will yield additional reserves of gas both from the Oriskany and deeper strata as extraction techniques are improved.

Page 20 is missing from the original 1982 Senior Thesis by Mary Beth Rafalowski.

APPENDIX A

Oriskany Core Descriptions (Taken from Ohio Dept. Nat. Resources)

A - Ashtabula Co., Plymouth Twp.; 1950

2007'-2012': Sandstone, white, medium and coarse rounded grains and medium subangular grains; 10% green smooth chert.

2012'-2015': Sandstone, white, fine and medium subangular grains; 5% green smooth chert.

2015'-2020': Sandstone, white, fine and medium subangular grains; 50% dolomite, dark brown, very finely crystalline; trace green smooth chert.

total thickness = 13'

B - Ashtabula Co., Plymouth Twp.; 1961

1909'-1912': 100% Sandstone, white, medium to coarse grained, subrounded, well sorted.

1912'-1917': 25% Sandstone, white, medium to coarse grained, subrounded, well sorted.

75% Limestone, tan to brown, fine to medium crystalline.

1917'-1923': 10% Sandstone, white, medium to coarse grained, subrounded, well sorted.

90% Limestone, tan to brown, finely crystalline.

total thickness = 14'

C - Ashtabula Co., Ashtabula Twp.; 1961

1631'-1641': 80% Sand, white, medium-coarse grained; subrounded to rounded, well sorted.

1641'-1650': 100% Sand, white, medium to coarse grained, subrounded to rounded, well sorted.

1650'-1659': 100% Sand, white, medium to coarse grained, subrounded to rounded, well sorted.

1659'-1665': 100% Sand, white, medium to coarse grained, subrounded to rounded, well sorted.

total thickness = 34'

E - Athens Co., Troy Twp.;

4245'-4252': Sandstone, light-gray; very fine and fine-grained with a few scattered medium grains; predominantly subangular to subrounded, large grains somewhat frosted; well cemented with siliceous cement, very slight amount of calcareous cement; tight sandstone

total thickness = 7'

F - Belmont Co., Smith Twp.; 1940

5651'-5669': Dense brown to blue brown slightly dolomitic limestone, Quartz sand increasing in amount downward.

total thickness = 18'

G - Belmont Co., Union Twp.;

5312'-5315': Sandstone, white, medium-grained, subrounded; well cemented with siliceous cement; minor amounts of calcareous cement, very slight trace of glauconite.

H - Carroll Co., Union Twp.;
4120'-4130': 50% Sandstone, medium-brown to grayish-brown, fine to coarse grained, subrounded to rounded, very calcareous, very slightly dolomitic, siliceous, very slightly glauconitic;
40% Limestone, medium-brown to grayish-brown, micro grained, siliceous, sandy in part.
10% chert, light-gray to light brownish-gray.
total thickness = 10'

I - Carroll Co., Augusta Twp.;
3839'-3845': 35% Sandstone, light-gray, very fine to fine grained, angular to subangular, slightly calcareous, very slightly dolomitic, slightly glauconitic; some siliceous overgrowths on grains; well cemented with siliceous cement.
35% Limestone, light-gray, micrograined, siliceous, slightly sandy (very fine to fine grained sand), slightly glauconitic.
30% chert, white to light-gray
total thickness = 6'

J - Columbiana Co., Butler Twp.; 1944
3773'-3780': Sandstone, fine to coarse grained;
20% gray limestone; much glauconite.
total thickness - 7'

JJ - Columbiana Co., Knox Twp.; 1945
3501'-3505': 90% Quartz sand grains well rounded and etched.
10% shale
3505'-3509': Quartz sand grains, grains are free, well rounded and etched, with some aggregates.

K - Columbiana Co., Madison Twp.; 1936
4417'-4448': Sandstone, light gray, fine, calcareous; slightly coarser near the top where at least part of the grains are well rounded;
4448'-4455': Sandstone, dark gray, very fine, calcareous.
total thickness = 38'

L - Coshocton Co., Tuscarawas Twp.;
2517'-2523': 60% Limestone, very light-gray to very light-brownish-gray; predominantly micrograined with a very few medium to coarse-grained fossil fragments (crinoids and brachiopods); dolomitic in large part; silty and sandy (very fine to fine grained sand) in part; a few argillaceous and pyritic partings.
30% chert, white to very light gray slightly dolomitic.
10% sandstone, very light-gray, very fine - to fine grained, subangular, silty, dolomitic, slightly calcareous.
total thickness = 6'

M - Coshocton Co., Keene Twp.; 1956
2630'-2643': 65% Sandstone, very fine quartz aggregates, fine and medium quartz grains.
30% limestone
5% chert, smooth and doloclastic white chert, trace of pyrite.

N - Coshocton Co., Franklin Twp.;
2578'-2593: Sandstone, white, medium to coarse grained, subrounded to rounded, frosted, calcareous, very slightly glauconitic, very slightly siliceous, slightly cherty; light iron oxide staining.
total thickness = 15'

O - Cuyahoga Co., Cleveland Harbor;
1293'-1298': 10% Dolomite, tan, finely crystalline, vuggy, sandy.
90% Sandstone, white, medium to coarse grained, subrounded to rounded, well sorted, friable.
total thickness = 5'

P - Cuyahoga Co., Cleveland City; 1955
1313'-1388': Sandstone, white, soft.
total thickness = 75'

Q - Cuyahoga Co., Cleveland City; 1957
1295'-1336': Sandstone, quartzose, white, poorly cemented.
total thickness = 41'

R - Cuyahoga Co., Cleveland City; 1956
1240'-1312': Sandstone, white, soft
total thickness = 72'

S - Cuyahoga Co., Cleveland City; 1956
1283'-1352': Sandstone, soft, white.
total thickness = 69'

T - Cuyahoga Co., Highland Heights Twp.; 1961
1901'-1909': 100% Sandstone, white, medium grained, subrounded to rounded, well sorted, friable.
1909'-1920': 100% Sandstone, white, medium grained, subrounded to rounded, well sorted, friable.
1920'-1925': 100% Sandstone, white medium grained, subrounded, well sorted, friable.
total thickness = 35'

U - Geauga Co., Chardon Twp.; 1941
2157'-2162': 10% Sandstone, white, fine to medium grained, subrounded to rounded, well sorted.
50% Dolomite, gray to brown, finely crystalline, sandy.
40% Chert, white, chalky, dolomitic.
total thickness = 5'

V - Geauga Co., Chester Twp.;
2300'-2334': 40% Sandstone, white, predominantly coarse-grained; many grains are broken and fractured, unbroken grains are subrounded to rounded, grains are frosted.
35% Chert, white and very light gray; very slightly dolomitic in part.
25% Dolomite very light brown - gray to very light gray-brown, predominantly very finely crystalline; slightly silty, siliceous and glauconite.
total thickness = 34'

W - Guernsey Co., Liberty Twp.; 1971
3580'-3590': Sandstone, white, medium, subangular to subrounded, glassy few coarse grains.
total thickness = 10'

X - Guernsey Co., Center Twp.;
3773'-3779': Sandstone, white medium and coarse grained, very slightly calcareous; subrounded to rounded and frosted. Chert, light iron oxide stain.
total thickness = 6'

Y - Guernsey Co., Cambridge Twp.; 1970
3427'-3450': Sandstone, white, medium, with a few coarse grains, subrounded to round, glassy calcareous, unconsolidated, soft. Shale streaks.
total thickness = 23'

Z - Guenrsey Co., Monroe Twp.; 1970
3730'-3760': Sandstone, white, light gray, loose, well sorted and highly polished. Fine to medium sized grained.
total thickness = 30'

Al - Harrison Co., Franklin Twp.;
4100'-4110': 50% Chert, white to light gray, fossiliferous.
25% Limestone, light to medium-brown-gray micro grained, dolomitic.
25% Sandstone white to light gray, fine to medium grained, subangular, calcareous.
total thickness = 10'

Bl - Harrison Co., North Twp.;
4260'-4270': Sandstone, white, medium-grained, subangular to subrounded, calcareous.
total thickness = 10'

Cl - Holmes Co., Walnut Creek Twp.;
3020'-3040': 85% Limestone, silty sandy (very fine to fine grained sand)
10% Sandstone, light gray to light brownish-gray, very fine to fine grained, subangular, very dolomitic (very fine crystalline dolomite) slightly silty, calcareous, very slightly glauconitic.
5% Chert, white to light gray.
total thickness = 20'

Dl - Jefferson Co., Salem Twp.; 1953
4898'-4900': Sandstone, white, fine grained, subangular.
20% Limestone, dark brown and dark gray to buff, dense to very finely crystalline; trace of glauconite.
4900'-4903': Sandstone, white fine to medium grained, subangular.
12% Calcareous material.
4903'-4905': Sandstone, white with red stain, fine to medium grained, subangular.
20% Calcareous material.

4905'-4910': Sandstone, white with red stain, fine to medium grained subangular.
5% Calcareous material.
4910'-4921': Sandstone, white with red stain, fine to medium grained, subangular.
20% Calcareous material.
4921'-4937': Sandstone, white, fine grained, subangular.
35% Calcareous material.
4937'-4940': Sandstone, white, slight amount of red stain, very fine to fine grained subangular.
65% Limestone, dark brown, dense to very finely crystalline.
total thickness = 42'

F1 - Jefferson Co., Island Creek Twp.;
5165'-5170': Sandstone, white, medium to coarse grained, angular to subangular, slightly calcareous; very heavy iron oxide staining.
total thickness = 15'

G1 - Lake Co., Kirkland Twp.;
2188'-2194': 90% Sandstone, white (some brown with iron oxide staining), medium-grained (some coarse grained), predominantly subangular but subrounded in some of the larger grains.
5% Chert, white - very light gray; some inclusions of sand grains and glauconite.
5% Dolomite
total thickness = 6'

H1 - Mahoning Co., Smith Twp.; 1941
3185'-3190': Limestone, gray dense, with glauconite and chert.
20% lime bonded sandstone; grains, fine to coarse; aggregates.
total thickness = 5'

I1 - Meigs Co., Lebanon Twp.;
4240'-4250': 60% Limestone, medium-brownish-gray, micrograined to very fine grained, very sandy, fossilferous.
40% Sandstone, white, calcareous, very fine to medium grained, subangular to subrounded; trace pyrite, white chert.
total thickness = 70'

J1 - Meigs Co., Olive Twp.;
4240'-4244': Sandstone, light brownish gray, fine to coarse grained, subrounded to rounded, frosted, very highly calcareous, very slightly glauconitic.
total thickness = 4'

K1 - Monroe Co., Center Twp.;
5508'-5518': Sand, quartz, fine grained, stained yellow brown, subangular grains, green free.
5518'-5524': Sand, angular and rounded.
5524'-5534': Sand, quartz, very angular grains, fine grained.
5534'-5540': Sandstone, large and small grains embedded in limestone matrix.

5540'-5560': Quartz sand, stained yellow brown, very fine grained.
5560'-5570': Sand, fine grained lime band, aggregates.
5570'-5571': Sand, black.
5571'-5581': Sand, fine grained limy.
5581'-5598': Limestone, white; sand, gray to gray brown.
total thickness = 90'

L1 - Morgan Co., Meigsville Twp.;
3720'-3725': 80% Sandstone, white, medium and coarse grained, subrounded and rounded, frosted, slightly calcareous.
20% Limestone, white to light gray, micrograined to fine grained, very slightly dolomitic, silty and sandy.
total thickness = 5'

M1 - Muskingum Co., Harrison Twp.; 1940
2995'-3000': 20% very fine grained, aggregate sandstone.
30% limestone
Chert, smooth
total thickness = 5'

N1 - Noble Co., Brookfield Twp.;
3820'-3830': Sandstone, white to light gray, fine and medium-grained, subangular, some siliceous cement, in part calcareous grading to sandy limestone.
total thickness = 10'

O1 - Stark Co., Sugar Creek Twp.; 1943
2808'-2814': 50% gray limestone
50% quartz sand
2814'-2819': 10% gray limestone
90% quartz sand
2819'-2829': 90% brown limestone
10% quartz sand
2829'-2840': 95% brown limestone
5% quartz sand
2840'-2855': 97% brown limestone
3% quartz sand
total thickness = 47'

P1 - Summit Co., Green Twp.; 1940
2936'-2939': 30% quartz sand, sand grains large, well rounded and pitted.
total thickness = 3'

Q1 - Trumbull Co., Hartford Twp.; 1961
3376'-3377': 100% Sandstone, white, fine to medium grained, subrounded, well sorted.
3377'-3381': 100% sandstone, white, fine to medium grained, well sorted.
total thickness = 5'

R1 - Tuscarawas Co., Auburn Twp.;
3090'-3100': 60% white chert
30% limestone, very light-gray, micrograined, slightly dolomitic; very slightly silty in part; very slightly siliceous.

10% sandstone, white, fine to coarse grained, angular to subrounded very slightly calcareous.

total thickness = 10'

S1 - Washington Co., Belpre Twp.;

4057'-4059': Sandstone, white to light gray, medium to coarse grained, subrounded to rounded, frosted, calcareous, very slightly glauconitic, slightly cherty, light iron oxide staining.

4059'-4060': Sandstone, white, fine to medium grained, subrounded to rounded, very slightly calcareous, very slightly cherty, light iron oxide staining.

4060'-4065': Sandstone, white, medium to coarse grained, subrounded to rounded, slightly calcareous slightly cherty; light iron oxide staining.

total thickness = 8'

T1 - Wayne Co., Chippewa Twp.; 1961

2345'-2360': 10% Sandstone, dolomitic, white, medium to coarse crystalline, well sorted, subrounded.

50% Dolomite, light brown to gray, finely crystalline, sandy, glauconite.

40% Chert, white to gray, chalky, dolomitic.

total thickness = 15'

WELL LOG DATA

APPENDIX B

Assigned Map #	Permit #	County	Township	Elev.	Depth to Top of Oriskany	Depth to Bottom of Oriskany	Thickness	Depth to Top of Onondaga	Onondaga-Oriskany **Interval**
1	923	Ashtabula	Conneaut	858	1,094	1,102	8	916	
2	573	Ashtabula	Wayne	1,019	1,515	1,527	12	1,469	
3	1,222	Ashtabula	Hartsgrove	828	1,231	1,242	11	962	
4	391	Ashtabula	Morgan	806	1,233	1,243	10	970	
5	641	Ashtabula	Richmond	1,034	1,451	1,458	7	1,236	
6	1,690	Athens	Troy	746	3,262	3,267	5	2,776	486
7	1,789	Athens	Dover	721	2,083	2,091	8	1,973	110
8	1,404	Athens	Bern	953	2,619	2,637	18	2,545	
9	277	Belmont	Mead	1,207	4,663	4,683	20	4,519	
10	515	Carroll	East	1,171	2,898	2,907	9	2,827	
11	332	Carroll	Monroe	1,109	2,819	2,839	20	2,533	286
12	1,409	Carroll	Brown	1,148	1,782	1,788	6	1,642	140
13	626	Columbiana	Madison	1,137	3,331	3,372	41	3,051	
14	698	Columbiana	Fairfield	1,116	2,860	2,878	18	2,596	264
15	2,459	Coshocton	Jefferson	1,062	1,286	1,292	6	1,174	112
16	3,474	Coshocton	White Eyes	888	2,036	2,044	8	1,878	158
17	3,248	Coshocton	Oxford	830	2,033	2,042	9	1,911	
18	958	Cuyahoga	Bedford	794	986	998	12	675	311
19	112	Geauga	Auburn	1,166	1,080	1,084	4	986	94
20	77	Geauga	Middlefield	1,258	1,254	1,262	8	1,090	164
21	23	Geauga	Montville	1,108	1,239	1,245	6	946	293
22	2,834	Guernsey	West Land	1,045	2,447	2,461	14	2,393	
23	1,831	Guernsey	Knox	1,015	2,385	2,401	16	2,255	
24	2,340	Guernsey	Wills	928	3,008	3,024	16	2,847	
25	1,025	Guernsey	Wills	871	3,045	3,057	12	2,940	105
26	2,154	Guernsey	Londonberry	1,040	3,155	3,162	7	2,980	175
27	103	Harrison	Green	1,126	3,679	3,694	14	3,502	177
28	95	Harrison	Franklin	1,087	2,999	3,021	22	2,837	162
29	104	Harrison	Freeport	1,127	3,096	3,114	18	2,934	162
30	236	Lake	Willoughby	640	836	845	9	612	
31	169	Lake	Madison	697	859	864	5	665	194
32	817	Mahoning	Beaver	1,140	2,313	2,319	6	2,195	
33	587	Mahoning	Youngstown	888	2,313	2,319	6	2,195	
34	2,208	Medina	Wadsworth	1,173	1,081	1,089	8	1,029	
35	1,184	Morgan	Manchester	959	2,901	2,909	8	2,803	
36	1,375	Morgan	Meigsville	670	2,872	2,900	28	2,616	
37	1,724	Meigs	Olive	886	3,188	3,192	4	3,146	42
38	1,566	Meigs	Columbia	725	2,057	2,067	10	1,979	

WELL LOG DATA

APPENDIX B (cont.)

Assigned Map #	Permit #	County	Township	Elev.	Depth to Top of Oriskany	Depth to Bottom of Oriskany	Thickness	Depth Top of Onondaga	Onondaga-Oriskany Interval
39	4,627	Muskingum	Licking	921	1,505	1,517	12	1,369	136
40	5,102	Muskingum	Licking	972	1,425	1,436	11	1,292	
41	2,245	Noble	Jackson	990	3,450	3,464	14	3,317	133
42	1,361	Noble	Brookfield	1,053	2,885	2,916	31	2,781	
43	1,913	Noble	Jackson	944	3,172	3,190	18	3,077	
44	818	Portage	Atwater	1,170	1,712	1,720	8	1,576	136
46	1,051	Portage	Edinburg	1,051	1,642	1,649	7	1,503	139
47	809	Portage	Hiram	1,188	1,300	1,307	7	1,158	142
48	2,594	Stark	Washington	1,216	2,207	2,216	9	2,044	163
50	1,839	Stark	Pike	1,115	2,211	2,218	7	1,989	
51	1,931	Stark	Sugar Creek	1,042	1,770	1,781	11	1,576	
52	3,324	Stark	Osnaburg	1,115	2,059	2,089	30	1,844	
53	3,386	Stark	Sugar Creek	1,210	1,848	1,865	17	1,765	
54	531	Summit	Boston	1,038	1,086	1,100	14	926	
55	826	Summit	Coventry	993	1,268	1,273	5	1,117	
56	1,341	Trumbull	Johnston	1,058	1,968	1,990	22	1,732	236
57	951	Trumbull	Farmington	844	1,616	1,638	22	1,344	272
58	754	Trumbull	Bristol	907	1,503	1,508	5	787	
59	512	Trumbull	Vienna	1,038	2,016	2,030	14	1,877	
60	1,766	Tuscarawas	Buck	934	1,999	2,012	13	1,842	
61	1,755	Tuscarawas	Rush	968	2,635	2,652	17	2,441	
62	2,307	Tuscarawas	Salem	1,003	2,301	2,313	12	2,246	55
63	2,416	Tuscarawas	Sugar Creek	1,010	1,984	1,994	10	1,815	
64	3,367	Washington	Waterford	913	3,262	3,289	27	3,130	
65	3,461	Washington	Palmer	830	3,091	3,100	9	2,994	
66	3,490	Washington	Watertown	885	3,223	3,241	18	3,115	
67	3,427	Washington	Waterford	884	3,035	3,049	14	2,913	
68	1,760	Wayne	Salt Creek	1,133	1,410	1,415	5	1,306	

APPENDIX C

CORE & CUTTING DESCRIPTIONS

Assigned Map #	Permit #	County	Township	Elev.	Depth to Top of Oriskany	Depth to Bottom of Oriskany	Thickness	Depth to Top of Onondaga	Onondaga-Oriskany Interval
A	13	Ashtabula	Plymouth	838	1,169	1,182	13		
B	3		Harperfield		1,909	1,923	14		
C	16		Ashtabula		1,631	1,665	34		
D	19	Lake	Concord	882	1,108	1,113	5		
E	1,060	Athens	Troy	790	3,455	3,462	7	3,353	
F	108	Belmont	Smith	1,174	4,477	4,495	18	4,267	
G	129		Union	1,233	4,079	4,081	2	3,877	
H	302	Carroll	Union		4,131	4,141	10	3,951	
I	82	Carroll	Agusta	1,114	2,725	2,731	6	2,462	
J	141	Columbiana	Butler		3,773	3,780	7	3,478	
JJ	152	Columbiana	Knox	1,097	2,404	2,417	13	2,099	
K		Columbiana	Madison	1,156	3,261	3,299	38	3,026	
L	2,059	Coshocton	Tuscarawas	754	1,791	1,797	6	1,635	
M	880	Coshocton	Keene	788	1,842	1,855	13		
N	1,972	Coshocton	Franklin	741	1,861	1,876	15	1,746	
O	267	Cuyahoga	Cleveland Harbor		1,293	1,298	5	966	
P		Cuyahoga	Cleveland City	584	729	804	75	384	
Q		Cuyahoga	Cleveland City	582	713	792	79	340	
R	1,837-D	Cuyahoga	Cleveland City	581	660	731	71	285	
S	1,031	Cuyahoga	Cleveland City	578	705	774	69	372	
T		Cuyahoga	Highland Hts.		1,901	1,925	24	1,530	
U		Geauga	Chardon	1,031	1,126	1,131	5		
V	7	Geauga	Chester		2,300	2,334	34	1,950	
W	1,444	Guernsey	Liberty	1,053	2,527	2,537	10	2,400	
X	334	Guernsey	Center	860	2,913	2,919	6	2,730	
Y		Guernsey	Cambridge	925	2,502	2,525	23	2,389	
Z	1,260	Guernsey	Monroe	1,048	2,682	2,712	30	2,483	
A1	95	Harrison	Franklin	1,087	2,001	2,011	10	2,846	
B1	101	Harrison	North	1,088	3,160	3,170	10	2,998	
C1	1,351	Holmes	Walnut Creek	1,211	1,561	1,570	9	1,596	
D1		Jefferson	Salem	1,062	3,836	3,841	5		
F1	830-A	Jefferson	Island Creek	1,310	3,855	3,860	5	3,680	
G1	1	Lake	Kirkland	1,072	1,116	1,122	6	719	

APPENDIX C

CORE & CUTTING DESCRIPTIONS (cont.)

Assigned Map #	Permit #	County	Township	Elev.	Depth to Top of Oriskany	Depth to Bottom of Oriskany	Thickness	Depth to Top of Onondaga	Onondaga-Oriskany Interval
H1	22	Mahoning	Smith	1,064	2,121	2,126	5	1,761	
I1	1,422	Meigs	Lebanon	628	3,602	3,612	10	3,508	
J1	984	Meigs	Olive	838	3,402	3,410	8	3,320	
K1	290	Monroe	Center	1,186	4,322	4,412	90	4,147	
L1	1,320	Morgan	Meigsville	878	2,848	2,854	6	2,752	
M1	146	Muskingum	Harrison	920	2,076	2,080	5	2,000	
N1	1,312	Noble	Brookfield		3,820	3,820	10	3,705	
O1	235	Stark	Sugar Creek	1,005	1,803	1,850	47	1,632	
P1	42	Summit	Green	1,165	1,771	1,774	3	1,518	
Q1		Trumbull	Hartford		3,376	3,381	5	3,141	
R1	1,060	Tuscarawas	Auburn	1,120	1,977	1,987	10	1,813	
S1	1,519	Washington	Belpre	646	3,411	3,413	2	3,327	
T1		Wayne	Chippewa		2,345	2,360	15	2,120	

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REFERENCES

Abel, Kathleen D., 1981, The Oriskany Sandstone in the Subsurface of Pennsylvania: Mineral Resources Report 81 Common Wealth of Pennsylvania.

Bennett, Johnson, et al., 1937, Devonian Shale and Oriskany Sand Drilling in the State of New York, Pennsylvania, Ohio, West Virginia, and Eastern Kentucky, in Oriskany Sand Symposium: Appalachian Geological Society, pp. 31-58.

Cardwell, Dudely H., 1974, Oriskany and Huntersville Gas Fields of West Virginia: West Virginia Geological and Economic Survey. Mineral Resources Series No. 5.

Dolly, E.D. and Busch, D.A., 1972, Stratigraphic, Structural and Geomorphic Factors Controlling Oil Accumulation in Upper Cambrian of Central Ohio; American Association Petroleum Geologists Bull., V. 56

Fettke, Charles R., 1938, Oriskany as a Source of Gas and Oil in Pennsylvania and Adjacent Areas: American Association of Petroleum Geologists; V. 22, no. 3, pp. 241-266.

Finn, Fenton H., 1942, Natural Gas in Oriskany Sandstone, Pennsylvania and New York: American Association of Petroleum Geologists, V. 33, pp. 303-308.

Gatlin, Carl, 1960, Petroleum Engineering, Drilling and Well Completions: Prentice-Hall, Inc., pp. 221-223.

Hall, John F., 1951, Oriskany Sand Study: Geological Survey of Ohio. Report of Investigations 13-14, pp. 39-42.

Janssens, Arie, 1976, Oil and Gas in Ohio, in Seminar on Industrial Self-Help Programs for Natural Gas Supplies: Ohio Geological Society, pp. 3-25.

Lafferty, Robert C., 1938, The Oriskany in West Virginia: American Association of Petroleum Geologists, V. 22, no. 2, pp. 175-188.

Lockett, J.R., 1937, The Oriskany Sand in Ohio, in Oriskany Sand Symposium: Appalachian Geological Society, pp. 61-64.

Manger, Edward G., 1963, Porosity and Bulk Density of Sedimentary Rocks: Geological Survey Bull., pp. E1-E55.

Myers, Thurman H., 1937, Past Development and Future Possibilities of the Oriskany Sand in the Appalachian Area, in Oriskany Sand Symposium: Appalachian Geological Society, pp. 21-30.

Oliver, W.A. et al., 1968, Devonian of the Appalachian Basin, U.S., in International Symposium on the Devonian System: Alberta Society of Petroleum Geologist, V. 1, pp. 1001-1040

Stow, Marcellus H., 1938, Conditions of Sedimentation and Sources of Oriskany Sandstone as Indicated by Petrology: American Association of Petroleum Geologists, V. 22, no. 5, pp. 541-564.

REFERENCES
(cont.)

Summerson, C.H., Swann, D.H., 1971, Patterns of Devonian Sand on the North American Craton and Their Interpretation: Geological Society of America Bull, V. 81, pp. 469-490.

Vanuxem Lardner, 1842, Geology of New York, Rept. on Third District.